



# **U. S. NAVAL SUBMARINE MEDICAL CENTER**

**Submarine Base, Groton, Conn.**

REPORT NUMBER 525

**THE RESPONSE ANALYSIS TESTER (RATER)  
AND  
LOGICAL INFERENCE TESTER (LOGIT)**

**II. Additional Pilot Study Data**

**By**

**James W. Parker**

**Bureau of Medicine and Surgery, Navy Department  
Research Work Unit MF022.01.04-9009.01**

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Naval Submarine Medical Center

17 May 1968



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## **SUMMARY PAGE**

### **THE PROBLEM**

To develop additional, normative data for the Response Analysis Tester (RATER) using geometric symbols as stimuli and to ascertain the effects of stress (flashing light distraction) on performance as measured by the Logical Inference Tester (LOGIT).

### **FINDINGS**

Based on a sample of 100 Navy enlisted men, the results showed that somewhat higher total scores were obtained with the geometric form stimuli than had been found previously using color stimuli. The only significant relationship found was between RATER scores and scores on the CLER portion of the Navy Basic Test Battery for men in non-technical (e.g. yeomen) rates only. Using two, pre-trained subjects, no significant decrements in performance (error) on LOGIT were found as a result of the flashing light distraction.

### **APPLICATIONS**

The additional experience with these two performance-measuring instruments has resulted in increased confidence in their usefulness. The data presented add to the cumulative data being collected and will augment base-line data available against which results from decrement-inducing studies can be compared.

### **ADMINISTRATIVE INFORMATION**

This investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit MF022.01.04-9009—Psychological Effects of Closed Habitat Stressors. The manuscript was approved for publication on 17 May 1968 and designated as Submarine Medical Research Laboratory Report No. 525. This is Report No. 1 on the current Work Unit, however, a previous report on these two testers (I. Some Preliminary Findings) will be found in SMRL Report No. 487; dated 2 February 1967, under MF022.03.03-9023.11.

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**PUBLISHED BY THE NAVAL SUBMARINE MEDICAL CENTER**

## ABSTRACT

This report presents additional, normative data for the Response Analysis Tester (RATER), a performance testing instrument, using geometric forms as stimuli. The results showed that somewhat higher scores were obtained with the geometric form stimuli than had been previously obtained using color stimuli. Examination of RATER scores as related to the Navy Basic Test Battery showed the only significant relationship to be between RATER scores and the CLER portion for men in non-technical rates only.

A second part reports the results obtained using the Logical Inference Tester (LOGIT) in a study to determine the effects of flashing light stress on performance. It was found that for two, pre-trained subjects no significant decrements in performance (number of errors) resulted from the addition of the flashing light while performing the test.

The additional experience with these two performance measuring instruments has resulted in increased confidence in their usefulness. The data presented add to the cumulative data being collected and will augment base-line data available against which decrement-inducing studies can be compared.

# THE RESPONSE ANALYSIS TESTER (RATER) AND LOGICAL INFERENCE TESTER (LOGIT)

## II. Additional Pilot Study Data

### INTRODUCTION

The first paper in this series (Parker, 1967) reported preliminary findings involving data obtained by means of the Response Analysis Tester (RATER) and the Logical Inference Tester (LOGIT) performance testing instruments. In that report, normative data were presented from 74 Navy enlisted men using RATER programmed with color stimuli. Also reported in the same paper were performance curves for a small sample of subjects solving a series of problems on LOGIT. Although alluded to in the first paper of this "family" of studies, it may be well to reiterate the purpose of collecting RATER and LOGIT data of this kind. Briefly, what is involved is a very real need to develop reliable measures of vigilance and cognitive function, necessary in ascertaining the performance effects of long duration exposure to real and simulated deep-sea conditions such as those provided by the SEALAB and similar programs. These two measurement approaches may also be useful for the diver selection problem, an area receiving considerable attention at the present time.

This paper presents additional normative data for RATER for 100 Navy enlisted men, this time using geometric shapes as stimuli. Too, the paper presents the results of a pilot study designed to measure the affects of stress (in this instance, a flashing light distraction) on LOGIT performance, using a series of problems involving two subjects. Since a complete description of RATER and LOGIT was presented in the first report, no attempt will be made to repeat those details in this report. The reader is referred to the previous report for this information.

### PROCEDURE

The test procedure was identical to that used in the previous study (Ibid.). The sub-

jects were seated in a straight-back chair in an air conditioned room with the subject console placed in front of him on a small table 26 inches in height. Communication between the experimenter and the subject was by means of an intercom system. Any deviations from this procedure will be mentioned in the section pertaining to the particular instrument.

### RATER

The stimuli used in this second study were four geometric shapes: circle, cross, triangle and diamond (Figure 1). The stimuli were presented in the viewing window of the subject console of RATER. Each subject was given a short briefing on the purpose of the study after which he was given a 5-minute practice trial in the self-placed mode so as to allow ample time to learn the association between each specific stimuli and appropriate response key. This orientation trial was followed by two 5-minute practice trials with RATER in auto-paced mode with a presentation rate of one stimulus per second.

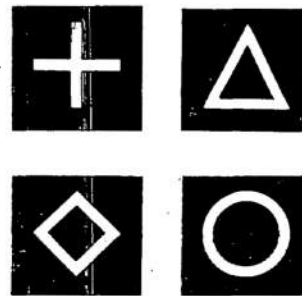


Figure 1. RATER Stimuli—four geometric shapes.

The results reported here are taken from a third, 5-minute, auto-paced trial. Two minute rest periods separated the trials. Performance was scored by subtracting the total

number of errors from the total number of correct responses. A perfect score, using the one per second presentation rate, would be 300. Both errors of omission and commission were recorded. In order to minimize guessing and random responding, the subjects were told at the outset of the testing session, that their scores would be penalized for wrong responses.

## LOGIT

The procedure for the actual administration of LOGIT in this study was the same as that reported in the first report in this series. However, during the experimental (distraction) test session, the Strobotac for producing the flashing light was placed on the table together with the LOGIT subject console. The flashing light was produced by a General Radio, Model 1538A Strobotac, which, in this experiment, was set to flash at the rate of 12 flashes per second. The reflector of the flash tube was directed downward so that it would not flash into the eyes of the subject, but at the same time, the light would illuminate the surface of the subject console. Moreover, with a view of monitoring the general excitation level (as reflected by peripheral autonomic indices) of the subjects during the LOGIT trials, electrodes were appropriately placed so as continuously to record heart rate and electrodermal conductance (EDC). An attempt was to be made to record EEG, but the Strobotac produced interference such that the EEG record was not usable because of the amount and nature of artifact present.

The two subjects used in the LOGIT experiment presumably had been trained to a plateau, both having solved more than 70 problems. That the LOGIT performance curves for these two subjects had leveled off, can be inferred from the fact that only one to three errors were made per problem — many with zero error score. In addition, both subjects were highly motivated and were competing with each other to see who could achieve the greater number of zero error total scores.

To rule out any inter-problem differences, the same problems were given to both sub-

jects in the same sequence. All problems had a Problem Index of 130. The procedure was to have each subject solve five problems without the flashing light (Phase 1), five with the flashing light (Phase 2) and then a final series of five problems again without the flashing light (Phase 3). Each phase of five problems was completed in five consecutive days, one problem per day and at the same approximate time of day for each subject. The hypothesis was that the introduction of the flashing light would act as a distracting agent, the result being a significant decrement in performance as indicated by the error score changes.

## RESULTS

### RATER

Figure 2 presents the frequency distribution of scores obtained in this study. The subjects were 100 Navy enlisted men whose mean age was approximately 20 years. These men were awaiting Submarine School and were selected, presumably at random, by the barracks Master-at-Arms. As in the aforementioned study, the distribution of scores was shown to be negatively skewed with a mean score of 223.5, and a standard deviation of 74.6. None of the subjects reported any difficulty in understanding the task or in operating the subject console. The mean GCT of the group was 59, which is equal to that reported in the first RATER Study and approximates the 80th percentile for the Navy-wide population.

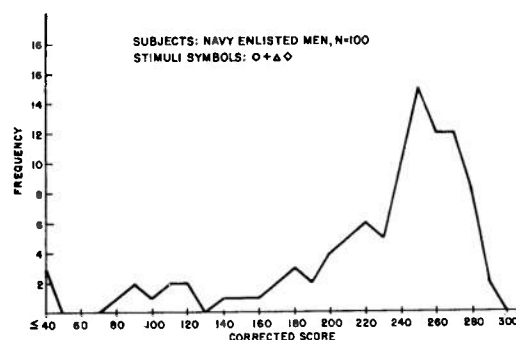


Figure 2. Frequency distribution of RATER scores.

Since the subjects were awaiting Basic Submarine School, some additional data were available as a result of the pre-school-screening process. These scores include the Basic Test Battery, the Personal Inventory Barometer (PIB) score and the final, overall grade assigned upon graduation from the School. The PIB is a psychiatric symptom questionnaire which is administered as a part of the psychological screening program preceding the School and subsequent submarine duty. Table 1 presents the intercorrelations of these variables with the RATER total score, as well as errors of omission and commission. It is to be noted that the sample size was reduced in this analysis, due to missing test score data as well as the fact that

Basic Battery ( $r = 0.35$ ). In the present study, this relationship did not re-occur ( $r = 0.02$ ). This difference in the RATER/MECH correlation may have been the result of: (1) differences in stimuli used (viz., colors in the first study vs. geometric forms in the present study), and/or (2) differences in subject samples. All other conditions were equated.

A comparison of the mean RATER scores from the first study using color stimuli, with the present study involving geometric shapes as stimuli, shows that the color stimuli resulted in a lower mean score (189.5) and a higher standard deviation (90.4). On the other hand, the present study produced a mean of 223.5 and a standard deviation of

TABLE 1. INTERCORRELATIONS OF VARIABLES, N = 79

	2	3	4	5	6	7	8	9	
1	23	15	-19	00	35	42	24	-06	SubScol Grade
2		42	-60	-04	08	05	04	-05	Error (Comm)
3			-98	15	20	07	02	-21	Error (om)
4				-12	-19	-07	-02	19	RATER Score
5					15	31	-12	-20	PIB
6						49	18	-05	GCT
7							08	12	ARI
8								-01	MECH
									CLER

NOTE: Decimal Points Omitted

not all subjects completed Submarine School for various reasons. The magnitude of the coefficients for statistical significance are: at the 0.05 confidence level, 0.22; and at the 0.01 level, 0.28. Examination of the Table shows that the only statistically significant correlation between the RATER scores and the other variables occurs between RATER errors of commission and the Submarine School grade ( $P < .05$ ). As would be expected, the two types of error — omission and commission — are highly interrelated. Too, since the total score is linearly dependent upon the error scores, a high, negative correlation results. It is to be noted that it was reported in the study that RATER scores were correlated with the MECH scores of the

74.6. An examination of the RATER frequency distribution (Figure 2) shows the clustering of frequency at the high score end of the score scale and the distinct negative skew. The fact that the RATER distribution for scores involving color discrimination showed a "sharper" negative skew, but a higher mean argues that discrimination of geometric shapes is easier than discrimination of colors for comparable samples of enlisted subjects.

There are perhaps several possible explanations for the differential discriminability of the two classes of stimuli, forms and colors. For one thing, the greater accuracy of discrimination between geometric forms (see Figure 1) may be the result of the relative

discreteness of the classes of concepts themselves; that is, triangle/square/circle/cross would appear to have discrete form differences, whereas blue/green and green/yellow may appear more or less disparate, depending upon color saturation of the stimuli and contrast of stimuli with surrounds.

To examine the last possibility, the relative brightness levels of the two classes of stimuli were measured under standard laboratory conditions. The results were as follows:

Circle	25 ft-lamberts	Red	9 ft-lamberts
Cross	25 ft-lamberts	Blue	18 ft-lamberts
Triangle	25 ft-lamberts	Yellow	65 ft-lamberts
Diamond	25 ft-lamberts	Green	23 ft-lamberts

Thus, it can be seen that there is no difference in the relative brightness of the geometric form stimuli, but there is wide variation in the relative brightness of the colors. There is less difference between blue/green as compared with red/yellow, for example. The lack of relative discreteness of the colors coupled with the wide variation in brightness and lack of distinct contrast with the surround perhaps accounts for the reduced accuracy of discrimination as compared with the geometric forms.

During the early stages of the analysis of these data, it was thought that those subjects in technical ratings (e.g., electronics technician, machinist mate, etc.) might characteristically achieve higher RATER scores than those in non-technical ratings (e.g. storekeeper, yeoman, etc.). However, a chi-square analysis showed this hypothesis to be untenable. Various cross-breaks of the data were examined for possible relationships and the single, non-chance (5% level) correlation being that between RATER scores and the clerical subtest of the Navy Basic Battery Test. This relationship existed only within the non-technical ratings included in the subject sample and not within the technical ratings. One possible explanation for this finding is that a person scoring high on clerical skills tends to pay close attention to detail and to perform repetitive tasks (e.g. filing and sorting) rapidly and accurately — skills which apparently are related to RATER performance.

## LOGIT

The results obtained with LOGIT are summarized in Table II. The results of the five trials in each of the three phases of the study have been lumped together. The Table presents the means, standard deviations and t-tests of significance between means. There were no significant differences between the Phase 1 (pre-experimental) and Phase 2 (experimental, distraction condition) between Phase 1 and Phase 3 (post-experimental) and between Phases 2 and 3. Subjective reports from the subjects said that the only effect they noticed was when the flashing light was activated which coincided with the signal to commence the problem-solving trial. They further reported that

TABLE 2. MEANS ( $\bar{X}$ ), STANDARD DEVIATIONS (S) AND T-TESTS OF SIGNIFICANCE BY SUBJECTS AND CONDITIONS FOR TOTAL TIME, FIRST TRIAL TIME AND NUMBER OF ERRORS

	Total Time		First Trial Time		Errors	
	Nd <sup>a</sup>	R <sup>a</sup>	Nd	R	Nd	R
Pre XPMTL N = 5	$\bar{X}$ 13.48 s 2.83 t 1.70	10.92 1.88 1.47	12.28 2.94 1.47	10.02 1.81 1.47	1.60 2.92 0.55	0.80 1.46 0.55
XPMTL N = 5	$\bar{X}$ 15.60 s 2.55 t 2.34*	11.44 1.55 2.05	14.36 2.63 2.05	10.62 1.51 2.05	0.60 1.00 1.33	0.00 0.00 1.33
Post XPMTL N = 5	$\bar{X}$ 13.70 s 2.07 t 2.91*	10.50 1.37 2.91*	12.70 1.75 2.91*	9.82 1.36 2.91*	0.20 0.50 0.91	0.00 0.00 0.91
Pre XPMTL	t 1.25	0.48	1.18	0.57	0.72	1.23
Pre Post	t 0.14	0.40	0.28	0.20	1.06	1.23
XPMTL; Post	t 1.30	1.02	1.18	0.88	0.80	0.00

\* $p < 0.05$ ,  $df = 8$

<sup>a</sup>"Nd" and "R" identify the two subjects

<sup>b</sup>N = number of trials in each session, 1 to 5

once past this point, they could proceed to solve the problem as they always had. There was some slowing, both in the time required to solve the problem to criterion (two successive, errorless trials), and in the time required for the first trial during which the subject follows a logical sequence in determining the order of button-pressing. These differences, however, were not statistically significant. With respect to the error scores,



there was a decrease in the number of errors made when progressing through the phases of the study. In fact, Subject R made no errors at all in either the experimental or flashing light phase and in the post-experimental phase.

In the course of the pre-experimental training prior to this study, it was noted that the two subjects used distinctly different approaches to solving the problems. While Subject Nd was a slow, methodical worker who sometimes took several minutes before proceeding (during which time he mentally was rehearsing the sequences), Subject R, on the other hand, charged ahead and routinely finished the problems in less time than Subject Nd. This inter-subject difference was maintained in this study. For both the experimental and post-experimental phases, there was a significant difference at the five per cent level between the subjects in the total time required for solving the problems to criterion. A significant difference was also found between subjects for the time required for the first trial in the post-experimental phase. Even though there was this difference in the time taken to complete the problems, there was no significant difference in their error scores.

The results obtained from the psychophysiological monitoring will not be included in this paper. These results, relating heart rate and skin conductance to LOGIT performance and the effects of distraction will be presented in a later report.

## SUMMARY AND CONCLUSIONS

This report has presented the results of additional work involving the RATER and LOGIT performance testing instruments. In this second RATER study, geometric figures were used as the stimuli. The results showed that somewhat higher total scores were obtained in the present study, indicating that perhaps the geometric figures presented a somewhat easier stimulus for the subject. Only one significant relationship was found between RATER scores and basic battery scores and that between RATER scores and

the CLER portion of the basic battery for non-technical rates only. No additional evidence for the concurrent validity of RATER was found in this study. Moreover, the usefulness of the RATER score as an index of general vigilance remains to be demonstrated. More importantly perhaps, the factors or conditions affecting RATER performance such as confinement and isolation, such as found in SEALAB type experimentation are, as yet, unknown.

The hypothesis in this study involving LOGIT was that there would be a significant decrement in performance resulting from exposure to a flashing light while engaged in problem-solving activity. With two, pre-trained subjects in a self-control design, the results showed no significant decrements in performance (errors) as a result of the flashing light. There are two possible explanations for this finding. First, the flashing light may not be sufficiently distracting generally to affect performance, second, in this experiment at least, a more plausible explanation might perhaps be that the level of training attained by the two subjects resulted in their being resistive to distraction of this kind. It follows then that it would be expected that subjects trained to a lower level of proficiency in solving LOGIT problems would show sizable decrements to the flashing light. It is to be noted however, that while LOGIT error scores were unaffected by the flashing light, the time to complete the problems were increased appreciably.

In short, the RATER Study has provided additional normative data, this time with form stimuli, as compared to a previous study involving colors. Similarly, the brief LOGIT Study, in addition to providing more normative information, provides an initial step in a series of studies designed to identify and weight those factors affecting high level cognitive function.

## REFERENCES

- Parker, J. W. The response analysis tester (RATER) and logical interface tester (LOGIT): I. Some preliminary findings. SUBMEDCEN Report No. 487, 2 Feb 1967.

## DOCUMENT CONTROL DATA - R &amp; D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Naval Submarine Medical Center, Submarine Medical Research Laboratory		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP N/A	
3. REPORT TITLE THE RESPONSE ANALYSIS TESTER (RATER) AND LOGICAL INFERENCE TESTER (LOGIT) II. ADDITIONAL PILOT STUDY DATA			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Interim report			
5. AUTHOR(S) (First name, middle initial, last name) James W. PARKER			
6. REPORT DATE 17 May 1968		7a. TOTAL NO. OF PAGES 5	7b. NO. OF REFS 1
8a. CONTRACT OR GRANT NO.		9a. ORIGINATOR'S REPORT NUMBER(S) SMRL Report No. 525	
b. PROJECT NO. MF022.01.04-9009.01		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.			
d.			
10. DISTRIBUTION STATEMENT  This document has been approved for public release and sale; its distribution is unlimited.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY Naval Submarine Medical Center Box 600, Naval Submarine Base Groton, Connecticut 06340	
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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
PERFORMANCE STRESS RATER LOGIT						